Office of Operating Experience Analysis, EH-33 • U.S. Department of Energy • Washington, D.C. 20585

OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

September 17 - September 23, 1999

Summary 99-38

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EVENTS

1. SAFE-ENERGY CHECKS REVEAL HAZARDOUS ENERGY FOLLOWING LOCK-OUT

OEAF engineers reviewed two occurrences at the Savannah River Site this week that underscore the benefit of performing safe-energy checks immediately before beginning work under safety lockouts. On September 14, 1999, at the F-Tank Facility, workers discovered 110-V ac proximity voltage during a pre-work safe-energy check on a distribution panel. Proximity voltage refers to any hazardous, unshielded voltage close enough to the work point (usually in the same enclosure) to present a hazard to workers. On September 13, 1999, at the Tritium Facility, workers preparing to modify a welding machine discovered 120-V ac inside a weld control station during a pre-work safe-energy check. In each case, shift operating personnel had signed that a lockout was satisfactorily established, and workers performing a conscientious safe-energy check discovered hazardous energy and eliminated the potential for serious injury. (ORPS Reports SR--WSRC-FTANK-1999-0029 and SR--WSRC-TRIT-1999-0022)

In the occurrence at the F-Tank Facility, workers were preparing an electrical panel for routine maintenance that consisted of re-labeling conductors, reworking grounds, and verifying jumpers. The work control package stated that proximity voltage sources in the panel required de-energization. However, the lockout plan did not address proximity voltage, and an electrician who performed a safe-energy check before the lockout was established did not detect proximity voltage. The voltage discovered by the workers after the lockout was established would not have presented a hazard to them if they had known of its existence and were able to take proper precautions. However, they would not have expected proximity voltage if they had relied solely on the information in the work control package.

In the occurrence at the Tritium Facility, construction personnel requested a two-point electrical lockout to install a design modification for a process welder. Instead, a lockout coordinator mistakenly wrote the lockout plan for an annual inspection of the welder bus bars. This is also a two-point lockout, but it uses a different breaker in the load center. Operating personnel tagged and locked electrical sources in accordance with the lockout plan, and engineering and maintenance personnel did not detect the error during their reviews. A maintenance electrician checked for the absence of voltage downstream of the lockout points indicated by the lockout plan but not at the actual work location. Investigators concluded that construction personnel, who were familiar with the scope of work, should have been involved in reviewing the lockout plan and performing safe-energy checks as the lockout was being established.

OEAF engineers searched the ORPS database and identified six additional occurrences reported this year by the Savannah River Site in which safe-energy checks by workers revealed inadequate lockouts. Five of these involved electrical work and one involved the discovery of a pressurized system during a mechanic's pre-work verification of isolation. Factors that can contribute to an inadequate lockout include inadequate facility design documentation, missing or inaccurate component labeling, miscommunication, and inattention to detail. The presence of hazardous energy after a lockout is established seriously compromises employee safety. Under the Savannah River Site hazardous energy control (lockout/tagout) program, a lockout coordinator, usually a member of the cognizant operating organization, writes a lockout plan. Personnel then use the approved plan to configure and tag equipment, independently verify configuration and install locks, conduct safe-energy checks, and review the completed lockout. When these steps are complete, final review and approval by an operating authority formally establishes the lockout and releases the work organization to begin work. Safety and health personnel at the Savannah River Site consider the discovery of hazardous energy after a lockout is established to be a reportable occurrence. As an added layer of protection, the site electrical safety procedure, which is independent of the hazardous energy control procedure, requires workers to perform their own safe-energy checks before they start work. NFS views this as a good practice and recommends that managers throughout the DOE complex ensure that the practice of pre-work safe-energy checks by workers is formally established and consistently implemented at their sites or facilities. The following references reinforce this practice.

- DOE/EH-0564, Issue No. 99-01, *Lessons Learned—Lockout Violations and Prevention Techniques*, states that each worker who signs on to a lockout should conduct an independent walk-down of the lockout and should verify that a safe-to-work energy check has been performed. This EH Lessons Learned Report is available from the OEAF home page at http://tis.eh.doe.gov/oeaf/ll.html.

- DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, states in Section 4.5.1, "Installation of a Lockout/Tagout," that the adequacy of protection should be verified by the individual(s) who will work under the lockout/tagout and that verification should include checking that electrical systems show no voltage and that fluid or pneumatic systems are vented or drained.

KEYWORDS: conduct of operations, independent verification, industrial safety, lockout and tagout

FUNCTIONAL AREAS: Industrial Safety

2. OPERATOR ERROR CAUSES SPILL OF CONTAMINATED WATER

On September 17, 1999, at the Idaho National Environmental Engineering Laboratory, an operator inadvertently opened a valve that resulted in the spill of contaminated process water. The operator was positioning valves in preparation for the start-up of an evaporator at the Specific Manufacturing Capability facility. The operator incorrectly opened the main flush valve to the evaporator, allowing wastewater to drain into a 55-gallon drum used for collecting solids from the evaporator process. The drum overflowed spilling approximately 20 gallons of process water onto the floor. When the operator saw the spill, he repositioned the valve stopping the spill. The operator did not have the approved operating procedure with him while performing the valve lineup. The failure to use the procedure resulted in a mispositioned valve and the spill of contaminated process water that required cleanup. (ORPS Report ID--LITC-SMC-1999-0004)

The evaporator at the facility is used in recycling process water that is generated from washing parts manufactured from depleted uranium. The evaporator is only operated when there is a sufficient amount of process water (batch-mode) to be recycled for use. The operator was tasked with positioning the valves to support the start-up of the evaporator. The operator was on a platform located above the evaporator while he positioned the system valves. After he opened the main flush valve, he proceeded with the lineup. When he looked down at the floor, he saw water overflowing from the 55-gallon collection drum and took immediate action to stop it. The water, contaminated with uranium oxides, was completely contained inside the evaporator area. A radiological control technician sampled the water for contamination, and a spill response team cleaned up the water.

Investigators determined that although the operator was trained, he had never performed this operation by himself and that he may not have been completely familiar with the system because of the infrequent operation of the evaporator. The operator did not have an approved operating procedure with him while performing the valve lineup.

NFS has reported many events in the Weekly Summary that involved valve misalignments. Weekly Summary 99-06 reported that plant engineering personnel at the Brookhaven National Laboratory incorrectly opened a bypass valve for an effluent treatment system filter unit, resulting in a release of tetrachloroethene that persisted for approximately 64 hours. The release exceeded the estimated average annual release specified in the facility application to a state regulatory agency. Plant engineering personnel had opened the bypass valve in response to instructions from a field engineer, who had based them on procedures that contained neither adequate detail nor formal valve alignment checklists. As corrective actions, facility personnel were tasked to develop appropriate valve alignment checklists. (ORPS Report CH-BH-BNL-BNL-1999-0003)

These events underscore the importance of using adequate procedures or following checklists when changing the alignment of facility equipment. Operators, performing evolutions for the first time or infrequent evolutions, should have procedures with them. It is also a good practice to have a second person, who is familiar with the evolution, assist or perform an independent verification of the alignment. Human actions are an important barrier to operating errors. DOE/EH-0502, Safety Notice 95-02, *Independent Verification and Self-Checking*, describes a technique that requires workers to (1) stop before performing a task to eliminate distractions and identify the correct component; (2) think about the task, expected response, and actions required if the expected response does not occur; (3) act by reconfirming the correct component and performing the task; and (4) review by comparing the actual versus the expected response. Safety Notices are available on the OEAF Home Page at http://tis.eh.doe.gov/web/oeaf/lessons_learned/ons/ons.html.

DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, provides the following guidance.

- Chapter II, “Shift Routines and Operating Practices,” states that it is the responsibility of the on-shift operating crew to safely operate the facility through adherence to operating procedures, technical specification or operational safety requirements, and sound operating practices.

- Chapter VIII, “Control of Equipment and System Status,” states that alignment checklists should be used to guide the operator in establishing the correct component positions. The alignment checklist should include provisions for (1) equipment nomenclature that matches the nomenclature placed on the component, (2) the required alignment position for each component, (3) a location to document the verification of each component, and (4) a location to document deviations from the required alignment.

- Chapter XVI, “Operations Procedures,” states that facility operations should be conducted in accordance with applicable procedures that reflect the facility design basis. The requirements for use of procedures should be clearly defined and understood by all operators. Operators should have procedures with them and follow them in a step-by-step manner when the procedures contain sign-offs for various activities. In addition, procedures should be referenced during infrequent or unusual evolutions when the operator is not intimately familiar with the requirements or when errors could cause significant adverse impact to the facility.

KEYWORDS: equipment status, operations, procedure, self-checking, spill, valve

FUNCTIONAL AREAS: Operations, Procedures

3. WORKER INJURED BY ROTATING PUMP SHAFT

On September 1, 1999, at the Rocky Flats Environmental Technology Site, a process specialist sustained lacerations to several fingers when his anti-contamination glove and cotton liner became entangled in a rotating pump shaft during a waste transfer operation. He immediately turned off the pump, exited the area, and requested assistance. Fire department personnel responded and transported the process specialist to the site medical department. Site medical personnel decontaminated his wounds and transported him to an offsite medical facility where his lacerations were treated. Rotating-equipment hazards can result in severe injuries or fatalities. (ORPS Report RFO--KHLL-NONPUOPS2-1999-0003)

Investigators learned that the process specialist had been tasked to transfer process waste from a tank in his facility to another building for treatment. The process waste transfer pump is located in a noisy area, and access is limited to trained personnel. The process specialist started the transfer pump but could not determine if the pump was running because of the high noise levels. He placed his hand on or near the pump and the anti-contamination glove and cotton liner that he was wearing caught in the rotating pump shaft.

The facility manager held a fact-finding meeting, and meeting attendees learned that a machine guard was in place on the pump shaft. The guard has a 3-inch by 6-inch opening to allow personnel to see the shaft. The facility manager directed facility personnel to review the machine guarding requirements to determine if this pump shaft was properly guarded and if other similar equipment is properly guarded. He also directed facility personnel to tag any rotating equipment that is not in service as having potential machine guarding deficiencies.

NFS has reported rotating equipment hazards in several Weekly Summaries. Some examples follow.

- Weekly Summary 99-36 reported that a maintenance carpenter at the Idaho Nuclear Technology and Engineering Center was exposed to a rotating-equipment hazard while adjusting a nearby scaffold railing. He was exposed to an unguarded blower motor fan belt because he did not place his personal lock and tag on the blower motor lockbox as required by a work order. Because work orders are not typically issued for scaffold modifications, the carpenter moved the railing without knowing that a work order had been issued or that it required him to install his personal lock and tag on the existing lockout/tagout. In addition, the carpenter did not realize that the exposed fan motor belt was a potential hazard. (ORPS Report ID--LITC-LANDLORD-1999-0012)

- Weekly Summaries 98-22 and 98-13 reported that an electrician at the Ames Laboratory Technical and Administrative Services Facility was severely injured when part of his clothing became entangled with a rotating shaft on a supply fan. A Type B Accident Investigation Board investigated the event and identified root causes of the event as (1) the failure to identify the exposed rotating shaft hazard, and (2) the lack of an Integrated Safety Management Program. (DOE/CH-AI98E, *Type B Accident Investigation Board Report on the March 27, 1998 Rotating Shaft Accident at Ames Laboratory Ames, Iowa*, April 1998; ORPS Report CH--AMES-AMES-1998-0002)

These events underscore the importance of recognizing and guarding against hazardous rotating equipment. The event at Rocky Flats is a good example of why plant personnel should avoid touching equipment as a means of determining its operating status. Operators can usually employ other means to verify equipment status which include checking (1) process flow instrument readings, (2) pump discharge pressure indications, (3) process tank levels, (4) pump motor current readings, and (5) pump run indicating lights. Plant procedures often contain steps for verifying equipment status after performing a specific operating action. These steps may direct operators to check specific instruments or indicators to verify equipment status.

The U.S. Department of Labor/Bureau of Labor Standards Bulletin, *The Principles and Techniques of Mechanical Guarding*, states: “Any rotating object is dangerous. Even smooth, slowly rotating shafts can grip clothing or hair. Accidents due to contact with rotating objects are not frequent, but the severity of injury is always high.” All motion hazards should be guarded through physical barriers. Locating equipment in non-inhabited areas does not prevent exposure to motion hazards within the enclosure. In the absence of engineered barriers, access to such areas should be restricted to personnel trained in the hazards present, using appropriate tools and safety equipment, and in accordance with established procedures.

Facility personnel responsible for industrial safety should conduct periodic walk-downs to identify safety hazards. Facility managers must ensure that corrective actions for identified hazards are effective and promptly implemented. Facility managers and personnel in charge of industrial safety should review the following guidance and ensure that it is reflected in plant configurations and administrative controls.

- 29 CFR 1910.212, *General Requirements for all Machines*, states that methods of machine guarding shall be provided to protect employees in the area from hazards such as rotating parts and shall be such that the guard is not an accident hazard itself. OSHA regulations can be found at http://www.osha-slc/.

- 29 CFR 1910.219, *Mechanical Power-Transmission Apparatus*, permits a shaft end to project not more than one-half the diameter of the shaft unless guarded by a non-rotating cap or sleeve based on a 1953 edition of ANSI [American Nuclear Standards Institute] Standard B15.1. The ANSI standard was revised in 1972, eliminating the allowance of any rotating shaft projections. Information on current industry practices is included in the 1996 revision of the ANSI/ASME standard. Information on the availability of standards can be found at http://www.ansi.org.

- OSHA publication 3067, *Machine Safeguarding*, *1992*, developed to aid in protecting workers against the hazards of moving machine parts, states: “any machine part, function, or process which may cause injury must be safeguarded.” It also states that when the operation of a machine or accidental contact can injure personnel in the vicinity, the hazards must be either controlled or eliminated. This publication describes various hazards of mechanical motion and presents some techniques for protecting workers. It is available at http://www.osha-slc.

KEYWORDS: rotating equipment, injury

FUNCTIONAL AREAS: Industrial Safety

4. NON-CONSERVATIVE TRITIUM MONITORING TECHNIQUE CORRECTED

On September 9, 1999, at the Mound Plant Tritium Facility, a radiological control technician (RCT) discovered tritium contamination on a fabrication mechanic who had been removing piping, valves, and pumps from a walk-in fumehood. The RCT performed a swipe survey of the mechanic’s head and determined a tritium activity in excess of the free-release limit, but he did not tell the mechanic the activity level. He adjusted the value by normalizing the result to an area of 100 cm^2. After normalizing the activity, the value was below the free-release limit for tritium, and the RCT told the mechanic that he was free to leave. Facility procedures require a bioassay for any contamination level greater than the free-release limit 90 minutes after exposure to tritium, regardless of the area of the swipe. By adjusting the value of the tritium concentration, the RCT reduced the activity level below the value that requires a bioassay (urine) analysis. The lead RCT for the facility noted the mechanic’s elevated tritium contamination level during a routine log survey. Internal dosimetry personnel contacted the mechanic, told him of the elevated tritium levels, and requested that he provide a bioassay sample. The results of the bioassay analysis were negative. Because the survey results were normalized to a lower value, facility managers did not recognize the potential for becoming contaminated during this work process, and a second worker became contaminated several days later while working in the same fumehood. This event is significant because non-conservative estimation or adjustment of contamination levels can result in missing a required bioassay, the unmonitored uptake of activity, and the potential for additional contaminated personnel. (ORPS Report OH-MB-BWO-BWO01-1999-0018)

Investigators determined that the mechanic was removing and bagging piping, valves, pumps, and part of the fumehood structure as part of a decommissioning operation. The mechanic was wearing a full set of anti-contamination clothing, and he was using careful handling techniques to prevent the items from touching him as he removed them. He was also wearing an extra set of gloves that he changed every 15 minutes to prevent tritium from permeating through the gloves to his skin. A continuous air monitor was located in the work area to warn personnel of any airborne tritium. The monitor did not detect increased levels of airborne tritium during the work. Investigators believe that the mechanic became contaminated from loose tritium that was on the components in the fumehood, possibly when he doffed his anti-contamination clothing and hood or as he bagged the objects for disposal. The RCT who surveyed the mechanic normalized the activity from 25,843 dpm/500 cm^2 to 5,000 dpm/100 cm^2, which is less than the free-release limit of 10,000 dpm. Facility managers now require RCTs to inform workers of their actual level of contamination and allow the workers to decide whether they want to wash and decontaminate if personnel swipe survey results are below releasable levels. Site personnel are also revising radiological control procedures to prevent the non-conservative practice of normalizing tritium swipe survey results and to conservatively assume that all personnel swipes are taken over areas of 100 cm^2.

Six days after the fabrication mechanic became contaminated, a demolition technician bagging components in the same walk-in fumehood became contaminated with tritium at a level of 12,398 dpm/500 cm^2. (ORPS Report OH-MB-BWO-BWO01-1999-0019) RCTs did not normalize this value to 100 cm^2 and conservatively reported the value as 12,398 dpm/100 cm^2, which is greater than the free-release limit. They decontaminated the technician to 1,143 dpm/100 cm^2 and released him. The technician then submitted a 90-minute bioassay sample that indicated 0.22 microcuries per liter, which is equivalent to an uptake of less than one millirem. Because two workers became contaminated during the same work process, facility managers suspended work and are performing an Integrated Safety Management assessment of the radiological work permit requirements and work controls for the decommissioning and bagging process in the fumehood.

DOE-STD-1098-99, *Radiological Control*, states that radiological workers are responsible for knowing their radiation and contamination exposure status to avoid exceeding radiological administrative control levels. This awareness should extend to being informed of contamination levels determined by swipe survey following each exit from a contamination area. The fabrication mechanic working in the fumehood should have asked for the results of the swipe survey instead of relying on the RCT informing him that he was below releasable levels. Personnel should recognize that their actions directly affect contamination control, radiation exposure, and the overall radiological environment associated with their work. By knowing their status, workers can provide valuable feedback into the work planning and control process to minimize their exposure and contamination. DOE-STD-1098-99 can be found at http://tis.eh.doe.gov/whs/rhmwp/ts.html.

DOE-HDBK-1079-94, *Primer on Tritium Safe Handling Practices*, provides information to operations and maintenance personnel about tritium, including its chemical and biological properties, tritium monitoring methods, and radiological control and protection practices for tritium. The primer can be found by search at http://tis.eh.doe.gov/techstds/.

KEYWORDS: bioassay, good practices, decontamination, personnel contamination, radiological worker, swipe

FUNCTIONAL AREAS: Decontamination and Decommissioning, Radiation Protection

5. WORKERS EXPOSED TO LEAD ABOVE OSHA PERMISSIBLE EXPOSURE LIMIT

This week, OEAF engineers reviewed two separate occurrences involving exposure to airborne lead above the OSHA permissible exposure limit of 50 micrograms per cubic meter as a time-weighted average over eight hours. On September 14, 1999, safety and health personnel at the Portsmouth Gaseous Diffusion Plant (PORTS) Environmental Remediation Program facility determined that one representative breathing zone sample collected on September 1 during a recycling project indicated an airborne lead concentration of approximately three times the OSHA permissible exposure limit. Four other workers in the general area may have been exposed to the elevated airborne lead levels. On September 17, 1999, at the Oak Ridge National Laboratory Plant and Equipment Division, an industrial hygienist received results of air samples indicating that a welder had been exposed to 5,500 micrograms of lead per cubic meter as a time-weighted average over eight hours. The welder was wearing a full-face respirator with high-efficiency particulate air filters for which OSHA assigns a protection factor of 50 for airborne lead. Consequently, the welder was potentially exposed to as much as 110 micrograms of lead per cubic meter after the protection factor is applied. These occurrences are significant because chronic and acute exposures to airborne lead can cause serious health problems. (ORPS Reports ORO--BJC-PORTENVRES-1999-0012 and ORO--ORNL-X10PLEQUIP-1999-0007)

At the PORTS Environmental Remediation Program facility, the project manager immediately stopped work when workers noticed dust on work surfaces. An industrial hygienist using lead check swabs confirmed that the dust contained lead. Based on the evaluation of breathing zone and general area sample analyses, safety and health personnel directed blood lead analyses for the five affected personnel and recommended analyses for remaining project workers. The project manager directed wet cleanup activities to remove residual lead from the work surfaces, and project team personnel are evaluating engineering controls to eliminate the lead hazard before restarting the project.

Investigators learned that a chromic acid tank, consisting of two layers of brick, a sheet-lead liner, and various accessories, had been dismantled in 1993 as part of a Resource Conservation and Recovery Act closure action. At that time, workers had cleaned the liner, cut and folded it, and placed it into new 55-gallon drums. Cleaning consisted of three separate steam cleanings and two cycles of washing with dilute sulfuric acid followed by a water wash. Facility personnel opened the drums in January 1999 for visual inspection and found no evidence of dust or dirt in the drums or on the liners. The work on September 1 consisted of removing the lead from the barrels and unfolding it to allow radiological control personnel to survey it for radioactive contamination. Lacking any contamination, the project involved repackaging the lead into B25 boxes for recycling as ordinary scrap. Work planners had evaluated the potential for loose lead contamination, but the job hazard analysis eliminated airborne lead as a concern based upon prior cleaning of the lead sheets and recent visual inspection. The work package required gloves and other personal protective equipment appropriate for physical hazards and respiratory protection if dust was detected. Workers detected the lead dust approximately two hours into the first work shift of the project.

The welder at the Oak Ridge National Laboratory was using an arc torch to cut the stainless steel casing from decommissioned spectrometer equipment. The stainless steel enclosed a lead casting that job planners believe contained calibration sources. According to a job hazard analysis, this stage of the work only involved cutting through the stainless steel casing, and based on this information, an industrial hygienist recommended that the welder use a full-face filter respirator. During the cutting operation, however, the stainless steel melted, heating and vaporizing part of the lead casting. The OSHA construction standard for occupational lead exposure, 29 CFR 1926.62, recommends a half-mask, air-supplied respirator operated in a positive-pressure mode for abrasive blasting, welding, cutting, and torch burning where lead is present.

NFS recently reported exposures to elevated airborne lead at the Los Alamos National Laboratory. Industrial hygienists at the Pajarito Laboratory determined that two Radiological Control Technicians (RCTs) received exposures to airborne lead exceeding the OSHA permissible exposure limit. Six RCTs removed approximately 1,300 lead bricks from a storage shed and stacked them outside the shed as part of a clean-up task that also involved labeling the bricks and checking them for radioactive contamination. A general hazard control plan and work authorization covering the work did not contain precautions specific to airborne lead exposure. Because of a concern about handling a large number of lead bricks inside a closed environment, work planners developed a procedure to augment the work authorization. This procedure required representative breathing zone air samplers for each work station and one for the general area inside the shed, but it did not require respiratory protection for any of the workers. (ORPS Report ALO-LA-LANL-TA18-1999-0012; Weekly Summary 99-34)

These occurrences underscore the necessity for conservative approaches in determining respiratory protection for employees who may be exposed to airborne toxic and hazardous substances. Measuring for airborne lead levels in the breathing zone of workers has little value, except to reveal overexposures retrospectively, if adequate interim protection is not provided. Mechanisms for the release of airborne lead from lead surfaces are poorly understood in general industry. Lead containing visible oxide in the form of loose white powder is an obvious warning sign. However, even bright lead can release lead dust readily when it is handled, scuffed, or formed. Because of the uncertainties surrounding the amounts of airborne lead that can result from various activities, some facilities have defined routine lead-handling tasks and have thoroughly evaluated and documented the airborne lead exposures associated with them. An example is the handling of a limited number of lead bricks per unit time during experiments or maintenance. These facilities consider all other lead-handling activities as off-normal, subject in all respects to the OSHA construction standard.

Industrial hygienists and work planners should be aware that many modification, dismantling, and refurbishment activities within operating facilities meet the intent of OSHA construction standards for protection from toxic and hazardous materials. Paragraph (d)(2) of OSHA's lead standard 29 CFR 1926.62, "Protection of employees during assessment of exposures," states, "…where lead is present, until the employer performs an employee exposure assessment and documents that the employee is not exposed above the permissible exposure limit, the employer shall treat the employee as if the employee were exposed above the permissible exposure limit and shall implement employee protective measures…" These measures, described in paragraph (d)(2)(v), include respiratory protection. Paragraph (d)(2) also lists the tasks requiring interim worker protection and provides data to guide the selection of appropriate respiratory protection. The intent of interim protection is to ensure that employees are not unduly exposed during exposure assessments. Paragraph (d)(3), "Basis of initial determination," relieves the employer of performing an initial monitoring program if reliable data from a prior monitoring program is available. However, current work processes, type of material, control methods, work practices, and environmental conditions must closely resemble those previously monitored and documented.

KEYWORDS: exposure, hazard analysis, industrial hygiene, permissible exposure limit, respirator, work planning

FUNCTIONAL AREAS: Industrial Safety, Work Planning

6. OSHA ALERTS WORKERS TO BERYLLIUM EXPOSURE

This week, OEAF engineers reviewed an Occupational Safety and Health Administration (OSHA) trade news release alerting workers to the hazards of exposure to beryllium, which can cause chronic beryllium disease (CBD). CBD is a disabling and often fatal lung disease for which there is no cure. OSHA is alerting workers because new scientific evidence indicates that OSHA's current permissible exposure limits for beryllium in the workplace may be too high to prevent

CBD. DOE has proposed a revision to the beryllium regulation for DOE sites, and OSHA will review the issue after the revision. In the meantime, OSHA has issued a Hazard Information Bulletin, *Preventing Adverse Heath Effects from Exposure to Beryllium on the Job*, to alert workers of the potential health hazards associated with exposure levels below current OSHA limits. (OSHA Trade News Release, dated September 17, 1999; OSHA Hazard Information Bulletin 19990902)

Beryllium is a metal found in nature that is extremely lightweight and hard. It is a good conductor of electricity and heat and is nonmagnetic. The use of beryllium in the United States began in the 1940's for use in making atomic weapons. It is still used today in that capacity as well as many others, including metal working, ceramic manufacturing, electronic applications, laboratory work, extraction, dental alloys, and sporting goods.

Researchers have learned that exposure to low levels of beryllium dust, fumes, metal, metal oxides, ceramics, or salts, even for a short period of time, can cause CBD in some workers. Beryllium and beryllium compounds can also cause lung cancer and skin disease. Currently, OSHA limits state that it is unsafe for workers to be exposed to more than 2 micrograms of beryllium per cubic meter of air for an 8-hour time-weighted average or more than 5 micrograms per cubic meter of air for more than 30 minutes. Additionally, workers should never be exposed to more than 25 micrograms of beryllium per cubic meter of air, regardless of how short the exposure. These limits have been in place for nearly 30 years.

In addition to possible changes by the DOE and OSHA to reduce the risk of CBD, the American Conference of Governmental Industrial Hygienists announced that it intends to reduce its current recommended exposure limits by 90 percent, from 2 micrograms per cubic meter of air to 0.2 micrograms per cubic meter of air averaged over an 8-hour work shift. The OSHA Hazard Information Bulletin recommends that employers use engineering controls, work practices, and personal protective equipment to limit beryllium exposure caused by inhalation and skin contact. OSHA also urges that exposed workers see a physician or a health care professional who specializes in occupational lung diseases for evaluation of beryllium sensitization (an allergic reaction that increases the risk of CBD) and the presence of CBD. CBD symptoms include an unexplained cough, shortness of breath, fatigue, weight loss or loss of appetite, fever, or skin rash. OSHA also urges that workers take a copy of the Hazard Information Bulletin with them when visiting their physician or health care professional. The bulletin also includes a list of research centers that offer health screening and surveillance programs to assist in identifying and treating beryllium-exposed workers who may have become sensitized or who may have CBD.

The action taken by OSHA stems from a number of scientific studies. The most recent study released earlier this year, demonstrates that even very low levels of exposure for as little as three months may cause beryllium sensitization in some individuals. The Hazard Information Bulletin is available at http://www.osha-slc.gov/dts/hib/hib_data/ hib19990902.html.

KEYWORDS: hazard analysis, industrial hygiene, industrial safety, occupational safety

FUNCTIONAL AREAS: Industrial Safety

FINAL REPORTS

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. VIEWING PORT ON PRESSURE VESSEL BURSTS DURING PRESSURIZATION

On May 20, 1999, at the Argonne National Laboratory—East, a researcher and a technician were pressurizing a stainless steel pressure vessel to 900 psi with nitrogen when one of three glass viewing ports failed at a pressure of 700 to 800 psi. Projectiles of glass chipped a masonry-blocked wall, shattered overhead fluorescent lamps, and severely damaged an overhead ventilation duct. The technician sustained minor cuts and abrasions on his arm, face, and head. Both individuals immediately left the room. After it was apparent that the situation was stable, they returned and shut off the nitrogen gas. Investigators learned that the researcher and the technician had just reinstalled the viewing port after placing a mirror in the vessel and that they both were aware of a readily visible flaw in the glass at the time of reinstallation. (ORPS Report CH-AA-ANLE-ANLEES-1999-0001; Weekly Summary 99-22)

The pressure vessel, which is a 2-ft long, 1-ft diameter cylinder, has a maximum allowable pressure of 1,100 psi with an operating pressure of 950 psi. The viewing ports are quartz measuring 3 inches by 7 inches and are 1.25 inches thick. They are held in place by metal fittings secured with bolts. The pressure vessel is used to examine the characteristics of diesel fuel aerosols. There was no fuel aerosol in the vessel when the technician pressurized it with nitrogen. Figure 1-1 shows the vessel with the failed viewing port (top).

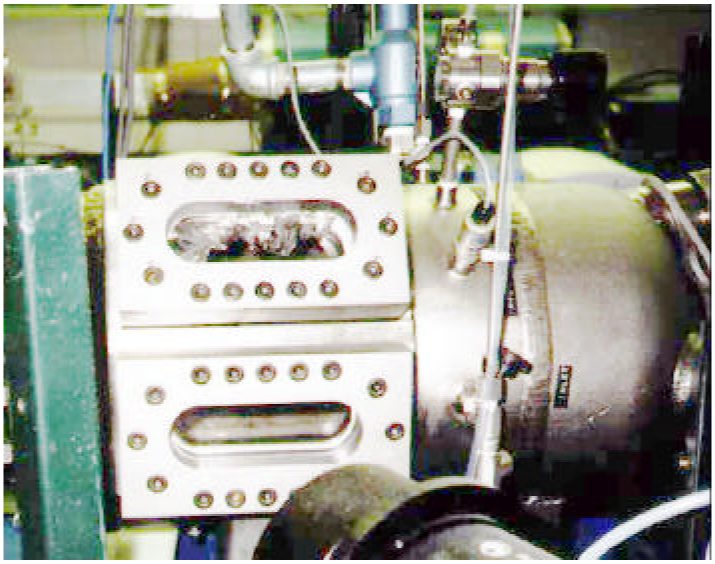

Figure 1-1. Vessel and Failed Viewing Port

The Energy Systems (ES) Division director and the Environment, Safety and Health (ES&H) coordinator conducted a comprehensive investigation that revealed facts leading to the determination of the causes. The division director arranged for assistance by members of the Argonne National Laboratory—East Pressure Technology and Safety Committee. As a follow-up to the investigation, committee members will also provide assistance with a readiness review for restart.

Investigators determined that the direct cause of the event was personnel error in that the response to the observation of a hazardous condition was inadequate. The researcher was aware that the quartz window had a 1-inch subsurface crack several weeks before the event, but he assumed that the window had been replaced. The technician had also observed the crack when he assembled the window on the day of the incident. Also, communication between the researcher and the technician was not adequate regarding the plan to increase the pressure from a 60-psi test pressure to 900 psi for a subsequent test. The technician communicated his apprehension when the pressure had been increased stepwise to approximately 700 psi, just before the window ruptured. Investigators also learned that the vessel had been operated several times at 950 psi without incident before the crack was observed.

Investigators determined that contributing causes included inadequate procedure/checklist for assembling the windows, the operators' lack of familiarity with the unique design characteristics of the device and its operational requirements, and inadequate design. The vessel has three view ports that penetrate the side of the vessel at different angles to allow for photographic and instrumental analysis of the fuel spray. The vessel also has a removable end plate penetrated by the fuel injector. The American Society of Mechanical Engineers (ASME) certification identified the bolts that secure the end plate to the vessel as the only "removable" bolts. Because the design did not include a dedicated cleaning port for removal of accumulated fuel on the inside surface of the glass, which interferes with optical measurements, the experimenters repeatedly removed and reinstalled one of quartz windows. This practice was not consistent with the design certification and required repeated handling of a vulnerable view port.

A vendor had designed and fabricated the vessel in accordance with ASME code. However, research personnel were not familiar enough with the code to evaluate conformance, and they incorrectly assumed that the scope of the code compliance included the windows. A post-incident evaluation of the design by independent Argonne National Laboratory (ANL) personnel revealed that the design was not consistent with established engineering practices for selection of safety factors for glass windows.

Investigators determined the root cause to be a combination of weaknesses and vulnerabilities in management and supervisory oversight, as well as in division management processes for safety review and control of the design process. ES Division policies require design reviews when new experimental equipment is needed. In this case, a formal design review was necessary but not performed. A formal design review by qualified ANL personnel that considered both functional and safety requirements would have probably revealed inherent vulnerabilities in the design. For example, the absence of the dedicated cleaning port resulted in repeated removal and installation of the vulnerable quartz window. In addition, a comprehensive design review would have probably revealed weaknesses in the vendor's selection of the thickness of the quartz.

Managers and supervisors failed to detect that the experimenters did not conform to the procedures established by the formal experiment safety review. Although a formal experiment safety review was conducted involving independent personnel with appropriate expertise (including pressure safety), the intent to repeatedly remove one of the quartz viewing ports was not discussed. The discussion of this inherent vulnerability would have facilitated an opportunity to systematically determine whether procedural controls or alternate access methods could adequately minimize the risks.

When the incident occurred, personnel involved in the design and initial operation of the system were no longer associated with the project. Supervisory direction to assure that newly assigned experimenters were prepared to use the system safely was inadequate. Supervisors incorrectly assumed that academic achievement and many years of experience, combined with the completion of topical safety training, were sufficient indicators that the personnel were capable of safely operating the test device. An ad hoc ANL committee, evaluating the site-wide implications of the event, identified that a plan to create a site pressure safety manual has not been completed after considerable time has elapsed. A chapter about pressure safety in the site ES&H Manual provides only general requirements for either conformance with the ASME code or application of equivalent rigor for design evaluation. In addition, although ANL provides pressure safety training on compressed gas cylinders and related devices, there is no formal training available on the fundamental principles and standards for design and use of pressure vessels.

The investigation team identified the following corrective actions.

- Established the criteria for a readiness review before restart. The criteria will include adequacy of (1) training and qualification of operators, (2) supervisory involvement and oversight, (3) operating procedures, and (4) equipment design as determined from input with independent analysts.

- Division experimenters visited the scene of the incident to observe the damage and learn about the consequences of the event from the division director.

- Establish a plan to evaluate and improve the design review process in the Energy Systems Division, including the identification of work activities, which may require a design review.

- Establish a plan to evaluate the experiment safety review process in the Energy Systems Division, and initiate appropriate improvements. The evaluation will include comparison of the division policies and procedures with the ANL requirements for establishing and implementing division-level experiment safety review processes.

- The division director will inform division experimenters about the event and its causes and will reinforce the requirements and expectations for hazard evaluation, work planning, and conformance with established standards and procedures.

This event underscores the importance having technical independent oversight and input from knowledgeable personnel when procuring equipment that must be designed and built. The change in personnel who were involved in the design and initial operation of the experimental system was a factor because they were no longer available to pass on their knowledge. Also, generic safety training courses may not be sufficient to assure safe operation of specific, custom-built equipment.

KEYWORDS: damage, design, injury, nitrogen, pressure vessel, pressurized, projectile, training

FUNCTIONAL AREAS: Design, Research and Development, Training and Qualification

2. FIRE INVOLVING DEPLETED URANIUM

On July 26, 1999, at the Lawrence Livermore National Laboratory, a technician noticed that the waste bag he was loading into a metal DOT Type 7A box was glowing and starting to expand. The waste bag contained materials contaminated with depleted uranium. He notified another technician that he had a fire and asked him to call the fire department. The other technician helped him place the lid on the box, and they evacuated the room. The fire department responded and extinguished the fire with Met-L-X agent. Laboratory managers suspended all uranium handling activities while they investigated the cause of the fire. None of the individuals involved, including fire department personnel, were contaminated. (ORPS Report OAK--LLNL-LLNL-1999-0034)

Investigators determined that the waste bag contained bulk amounts of uranium. They believe that the uranium was disturbed while being placed in the 7A box causing it to spontaneously combust and ignite tissue paper wrapped around a uranium-contaminated graphite part.
The facility manager attributed the occurrence to the following causes.

Direct Cause: Equipment/Material Problem, Contaminant – The double-bagged waste contained unanticipated bulk quantities of depleted uranium.

Contributing Causes: Personnel Error, Procedure Not Used or Used Incorrectly – The technician did not open and fully assess the bagged waste in accordance with low-level waste procedures. Procedures allow assessment based on process knowledge. However, the technicians had minimal knowledge of historical practices.

Personnel Error, Communication Problem – The building supervisor was out sick on the day of the event. The separator operations manager discussed the disposal work with the technicians on that day. However, he assumed that the double-bagged waste met current storage practices when he conducted the job briefing with the technicians.

Radiological/Hazardous Material Problem, Legacy Contamination – The double-bagged waste was placed in storage in 1994. Requirements in 1994 did not include complete cleaning of parts before being stored as waste.

Root Cause: Management Problem, Policy Not Adequately Defined, Disseminated, or Enforced – Managers failed to ensure that low-level waste handling procedures were being followed. These procedures rely on technicians having process knowledge of the materials inside waste containers. Technicians experienced in historical practices had been laid off as the result of a reduction in workforce, and managers did not take the necessary steps to ensure that waste materials were disposed of in a safe manner.

The facility manager has required that all waste parcels and equipment must be transferred to waste containers in a confinement room. All waste parcels and equipment will be disassembled to allow technicians to determine the physical and chemical form of uranium contamination before disposal. All waste containers previously filled as part of this project will be recalled to the confinement room, and their contents will be fully inspected for bulk amounts of uranium.

Weekly Summery 99-03 reported a similar event involving inappropriate reliance on process knowledge. A radiological control technician at the Rocky Flats Environmental Technology Site Non-Plutonium Operations Area opened four 55-gallon drums and two 10-gallon drums without the appropriate work controls in place. The drums contained depleted uranium chips. Investigators determined that no work package or procedure was used. They determined that facility personnel permitted the technician to open the drums because they thought they knew the contents of the drums and associated hazards based on process knowledge. Opening the drums could have caused the chips to oxidize, resulting in sparking or a fire. (ORPS Report RFO--KHLL-NONPUOPS2-1999-0001)

These events highlight the need for facility managers to verify that work control documents address the hazards of handling material that has been packaged and stored for several years. This includes performing inspections of waste container contents, especially when process knowledge has been lost through worker turnover. Because past facility operations may not have been conducted in a manner consistent with current practices and requirements, it is not unusual to find conditions different from those expected. Although the use of process knowledge can be helpful, this knowledge must be current and accurate before it can be relied upon. When process knowledge is gained from secondary sources or is assumed from incomplete knowledge of past operations, additional safety precautions should be implemented. In addition, workers need to be aware of the hazards associated with storing, opening, and handling legacy waste containers. Facility managers must develop appropriate programs and procedures to identify all associated hazards before performing work.

Facility personnel should be aware of the importance of using caution when working with pyrophoric metals. Personnel involved in such activities should fully understand the potential reactions associated with the materials. Hazards that could cause or contribute to the severity of a combustible metal fire should be identified by a hazard analysis, and measures to minimize the hazards should be implemented.

Facility managers should review the following documents for more information on the safe handling of pyrophoric metals.

- DOE-HDBK-1081-94, *Primer on Spontaneous Heating and Pyrophoricity*, provides information for the identification and prevention of potential spontaneous combustion hazards. It also identifies metals and gases known to be pyrophoric, acceptable methods for long-term storage, proper extinguishing agents, and additional sources of reference materials available on these subjects. The handbook can be obtained at http://www.doe.gov/html/techstds/standard/standard.html.

- National Fire Protection Association, *Fire Protection Handbook*, chapter 4-16, “Metals,” provides guidance on the fire hazard properties of combustible metals, including uranium. It states that uranium is subject to spontaneous ignition and that fires have occurred spontaneously after prolonged exposure to moist air. Ordering information for NFPA documents may be found on the NFPA home page at http://www.nfpa.org.

- DOE-HDBK-1113-98, *Radiological Safety Training for Uranium Facilities*, is a program management guide that provides guidance for proper implementation of training as outlined in the *DOE Radiological Control Manual* and is meant to comply with the training required by 10 CFR 835. It contains information on the physical, radioactive, and chemical properties of uranium and discusses uranium fire hazards and their toxicological and biological effects. The handbook can be obtained at http://tis.eh.doe.gov/techstds/standard/hdbk1113/hdbk1113.pdf.

KEYWORDS: uranium, pyrophoric, procedures

FUNCTIONAL AREAS: Procedures, Materials Handling/Storage

OEAF FOLLOWUP ACTIVITY

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